2. (Amended) A substrate with a transparent conductive film according to claim 1, wherein said indium tin oxide has a tin oxide content of 4 to 6 wt%.--

Please add the following claims:

--6. (New) A method of producing a substrate with a transparent conductive film, comprising:

providing a transparent substrate; and

ion plating a transparent film on a surface of said transparent substrate by using indium tin oxide which is a mixture of tine oxide and indium oxide as a material to be vaporized,

wherein the transparent conductive film has a work function of 4.9 to 5.5 eV, a surface roughness of 1 to 10 nm and a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot cm$ or less.

7. (New) A method according to claim 6, wherein said indium tin oxide has a tin oxide content of 4 to 6 wt%.--

REMARKS

Pending claims 1-5 have been rejected. Claims 1 has been amended to recite that the transparent conductive film is formed on the surface of the transparent substrate by an ion plating method by using indium tin oxide, which is a mixture of tin oxide and indium oxide, as a material to be vaporized, as supported by original claim 2. This recitation has been removed from claim 2. New method claims 6 and 7 contain all of the elements of the product claims 1 and 2. Accordingly, they should be examined and allowed together with the product claims. Claims 1-7 thus remain in the case.

Claims 1-5 are rejected under Section 103(a) based on U.S. 6,303,239 ("Arai") in view of applicants' admitted prior art and further in view of U.S. 5,180,476 ("Ishibashi"). The examiner states that Arai discloses a transparent substrate and a hole injecting electrode made of transparent ITO that has a work function of 4.5 to 5.5 eV. The layer is formed by DC magnetron sputtering. There is no suggestion of a film formed by ion plating, as presently claimed. The examiner admits that Arai does not disclose a film having a surface roughness of 1 to 10 nm and

a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot$ cm or less, but argues that applicants disclose prior art that has a surface roughness of 10 nm or less, and cites Ishibashi as teaching a surface resistance of $1.6 \times 10^{-4}\ \Omega \cdot$ cm or less.

The present invention provides a transparent substrate with a transparent conductive film having the following properties:

(i) a work function of 4.9 to 5.5 eV,

(ii) a surface roughness of 1 to 10 nm, and

(iii) a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot$ cm or less.

While one can attempt to pick and choose techniques that allow each of these criteria to be satisfied individually, there is no suggestion or motivation in prior art for forming a substrate that satisfies all three parameters. Indeed, as taught in the background of applicants' specification, production of ITO films by conventional DC sputtering produces films that have a high surface roughness, and require a separate annealing step to smooth the surface. Even then, the film has an unacceptably high specific resistance. Ishibashi attacks one of the two problems with conventionally sputtered ITO films, by modifying the sputtering parameters to reduce specific resistance in the ITO film. Like Arai, Ishibashi does not teach using ion plated indium tin oxide films as presently claimed, which have a work function of 4.9 to 5.5 eV, a surface roughness of 1 to 10 nm, and a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot$ cm or less.

These references do not address the problem of high surface roughness. In this regard, the examiner urges that applicants' "admitted prior art" includes a teaching of a transparent conducting film having a surface roughness of 10 nm or less, and that minimized surface roughness prevents the formation of dark spots and increases durability. The film described at lines 18 and 30 of page 3 of the present disclosure, however, clearly displays a specific resistance higher than that obtained with films prepared by ion plating in accordance with the present invention. Thus, the combination cited by the examiner fails to suggest how a work function of 4.9 to 5.5 eV, a surface roughness of 1 to 10 nm, and a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot$ cm or less, all can be achieved together.

The closest prior art in this case is believed to be Arai, which discloses ITO films produced by conventional DC sputtering, but does not use a surface anneal. Thus, Arai discloses:

> Then, the substrate was fixed to a substrate holder in a sputtering system, where an ITO hole injecting electrode layer was formed by a DC magnetron sputtering process using an ITO oxide target.
>
> The substrate with the ITO film formed on it was ultrasonically washed with neutral detergent, acetone, and ethanol, and then pulled up from boiling ethanol, followed by drying. The substrate was subsequently cleaned on its surface with UV/O3. Then, the substrate was fixed to the substrate holder in a vacuum evaporation system, which was evacuated to a vacuum of 1 x 10-4 Pa or lower.

The specification includes a comparison to as much as is disclosed in the closest prior art cited by the examiner. Comparative Examples 1-3 all were formed by conventional DC sputtering, whereas Examples 1-3 all were formed with ion plated ITO films as taught by applicants. The films formed by conventional DC sputtering as in Arai, all had one or more parameters that were outside the scope of applicants' claims. The films according to the invention, on the other hand, simultaneously exhibited a work function of 4.9 to 5.5 eV, a surface roughness of 1 to 10 nm, and a specific resistance of $1.6 \times 10^{-4}\ \Omega \cdot cm$ or less. No prima facie case of obviousness exists based on the combination of art cited by the examiner.

With respect to claim 2, which more particularly recites that the ITO has a tin oxide content of 4 to 6%, the examiner's comments regarding the process of manufacturing is moot as claim 2 only recites the physical property of the ITO. Accordingly, the tin oxide content must be considered and given weight.

Finally, the examiner takes the position that "the transparent conducting film disclosed by Aria in view of the applicants' admitted prior art is at least a fully functional equivalent to applicants' claimed invention." The data in the specification clearly rebuts the assumption that the film in Arai is a functional equivalent of the present films, by showing that films produced by conventional DC sputtering (which Arai must be presumed to be, in the absence of any specifics of the sputtering technique used) have a high specific resistance. Films with a high specific

resistance have increased power consumption and degraded display quality (see page 5 and the discussion of the performance characteristics of the Comparative Examples provided on pages 19 and 20 of the present disclosure).

Based on the foregoing, it is submitted that the claims in this case are allowable, for which applicants solicit an early Notice of Allowance. Should there be any matter requiring further attention, the examiner is invited to contact the undersigned at the telephone exchange provided below.

Petition for Time Extension

Applicants request a one-month extension, from October 31, 2002 to November 2, 2002, for replying to the outstanding Official Action. The one-month extension fee is $110. The Commissioner is authorized to charge $110 (or any additional fees required to maintain the pendency of this application) to Deposit Account No. 18-2056.

Respectfully submitted,

LYLE KIMMS
REG. NO. 34079

Marc A. Rossi
Registration No. 31,923

Date: December 2, 2002

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ATTACHMENT

MARKED UP VERSION

Claims 1 and 2 have been amended as follows:

--1. (Amended) A substrate with a transparent conductive film, comprising a transparent substrate, and a transparent conductive film formed on a surface of said transparent substrate, wherein said transparent conductive film has a work function of 4.9 to 5.5 eV, a surface roughness of 1 to 10 nm, and a specific resistance of 1.6×10^{-4} Ω · cm or less,

wherein said transparent conductive film is formed on the surface of said transparent substrate by an ion plating method by using indium tin oxide which is a mixture of tin oxide and indium oxide as a material to be vaporized.

2. (Amended) A substrate with a transparent conductive film, according to claim 1, [wherein said transparent conductive film is formed on the surface of said transparent substrate by an ion plating method by using indium tin oxide which is a mixture of tin oxide and indium oxide as a material to be vaporized, and] wherein said indium tin oxide has a tin oxide content of 4 to 6 wt %.--